Case Study 3.2
Team 7

Executive Summary

The following report focuses on analyzing uncertainty variables and finding solutions to maximum profit. George Clark plans to start his own label wine business, he plans to buy grapes from other nearby growers due to maintain a positive cash flow during the first few years. The initial investment cost for producing grapes and promoting expense are $10,000. And he determined to produce his favorite Petite Sirah and popular Sauvigon Blanc. According to the production cost, selling price, adverting cost, and estimated demand, our tasks are to estimate and optimize the profit over that period by using linear programming (LP) model. Based on the results from LP model, sensitivity report, and limits report, we provide some realizable suggestions for this start-up business.

Business Problem:

Business Question(s) for sub- problem 1 < *Book problem 1*>:

- How to distribute money between purchasing grapes and marketing each year for each quality?
- How many bottles of each quality to sell each year, should any of the bottles be kept in inventory even if it could be sold?
- How could the profit be maximized for the 2 years?

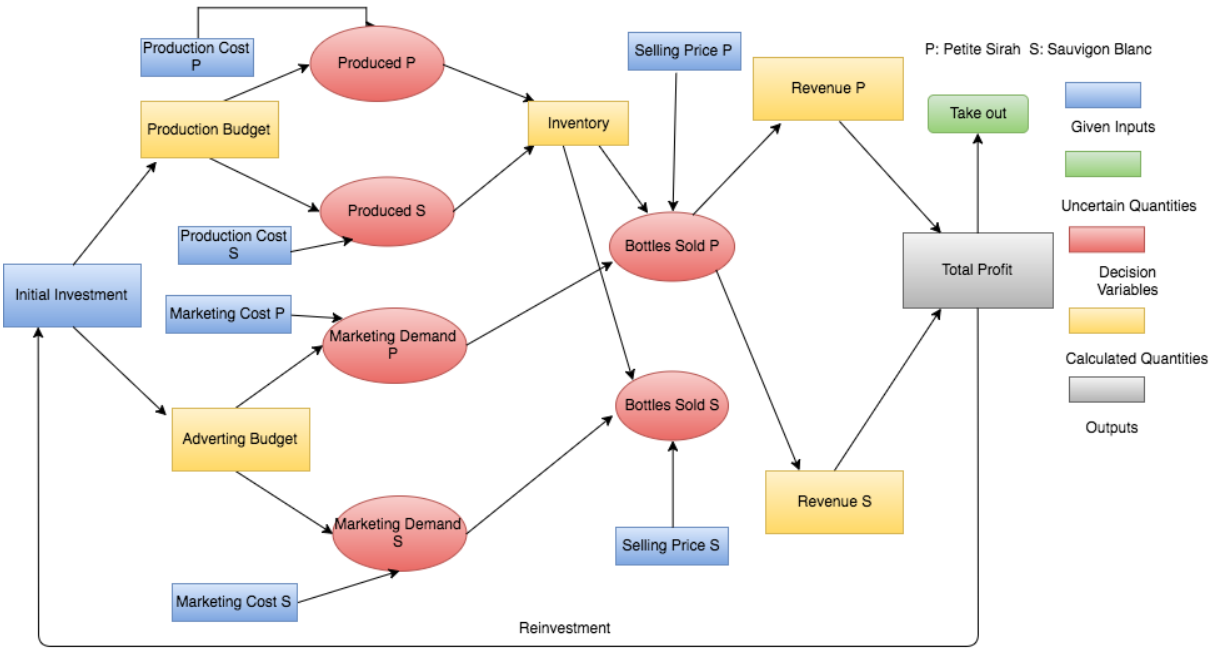
Business Question(s) for sub- problem 2 < *Book problem 4*>:

- How does grape cost affect George's plan (w.r.t profit and revenue generated in two years)?

Business Question(s) for sub- problem 3: < *Book problem 5*>

- How does the discount rate affect the overall profit, the concern of George's colleague?
- How does the coefficients of objective function vary with different discount rates?

To help create to LP model and understanding the problems in this case, we draw a Big Picture in the following:



Model Description

Overall Assumption:

- Cash earned in the first year from the wine sales will be available in the second year
- Bottles produced/sold, inventory etc. cannot be negative
- All constraint, inputs do not change with respect to what is given in the problem.
- No other factors, other than the ones mentioned, affect the final profit.
- Bottles produced cannot be a decimal value. But, for the sake of calculations, we have not included this as a constraint as sensitivity report cannot be generated in Microsoft Excel Solver for integer constraints. We have rounded off the values for all such instances

Inputs:

For all the three sub problems mentioned above, majority of the input variables are same. The common/ constant input variables are:

- Initial investment (money) in terms of Dollars ($)
- Cost of grapes required to produce a bottle of each quality of wine each year
- Expected revenue to be generated per bottle of each quality of wine each year
- Expected demand to be generated per dollar of marketing for each quality each year

	Year1		Year2	
	Petite Sirah	Sauvignon Blanc	Petite Sirah	Sauvignon Blanc
Initial investment (Money)		$10,000.00	To Be Derermined	
Production cost/bottle	$0.80	$0.70	$0.75	$0.85
Estimated revenue/bottle	$8.00	$7.00	$8.25	$7.00
Expected demand/$ marketing	5	8	6	10

Table 1.1

- For sub problem 2, in addition to the inputs mentioned in "Table 1.1", **Percentage increase in grape cost** is also included as input
- For sub problem 3, in addition to the inputs mentioned in "Table 1.1", **discount factor** is considered as an input

Decision Variables:

- Quantity of bottles produced of each quality of wine each year*
- Cost of marketing for each quality of wine each year
- Units to be sold for each quality of wine each year**

We can do the same calculation by just taking Cost of marketing for each quality of wine each year as the decision variables. In that case We will can take the number of bottles produced = demand generated and sell of all the bottles, since there is a demand there is no need to maintain an inventory. But is it a robust model?

*What if there is a sudden forecast that the selling price of a wine type is expected to drop, and is even below our breakeven point? In that case, we will not produce that wine quality even though we had earlier spent money on its marketing.

**What if the Revenue generated / quality is forecasted to shoot up exponentially? In that case even though the demand is there, we will intentionally not sell the bottles and stock them up for the next year when they can be sold for a much-inflated cost. This cannot be done if we don't include the third parameter.

We need to brainstorm properly and consider such factors before making inefficient models.

Constraints:

We would like to layout constraints at sub-problem level-

Constraints		
Total Bottles Sold per quality per year	<=	Total Bottles in inventory after production per quality per year
Bottles Sold per quality per year	<=	Maximum demand per quality per year
Total bottles sold for Petite in each year	>=	40% of total bottles sold each year
Total bottles sold for Petite in each year	<=	70% of total bottles sold each year
Cost incurred for each year	<=	Available Capital for each year

Solution methodology:

We have maximized the profit after 2 years by satisfying all the given constraints. We have a provision for an inventory, our model is immune to sudden increase or decrease in the wine or grape price for each year.

We have used the Simplex method of Microsoft Excel to arrive at our conclusion.

Output:

- For sub problem 1, the desired output is the Maximum value of total profit after 2 years.
- For sub problem 2, the output measured is the effect of **percentage increase in grape cost over Total profit earned**
- For sub problem 3, in addition to Total profit earned, NPV is also measured as an output and it is analyzed further by varying the "Discount rate". The effect of "Discount rate" on coefficients of decision variables is also calculated.

Results and Recommendations:

Result of Sub-problem 1-

With the given constraints and input values, from our model, we can observe the following-

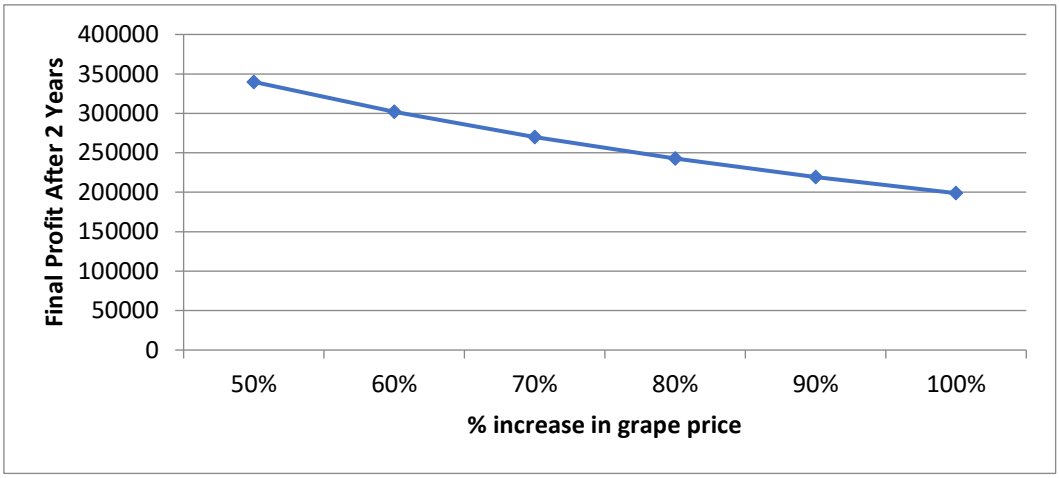
- With the initial investment of just $ 10,000, split between $1,731 for marketing and the rest for grape production, we anticipate George can generate revenue of $82,681 after 1st year and $702,645 after 2nd year. With a total turnover of $785,326

- If George allocates resources as highlighted in the model, he would be able to make profit of $72,681 after 1st year and $619,963 after 2nd year, with a total profit of $692,645
- George should produce & sell 11173 bottles for the 1st year and 89225 units for the 2nd year

Result of Sub-problem 2-

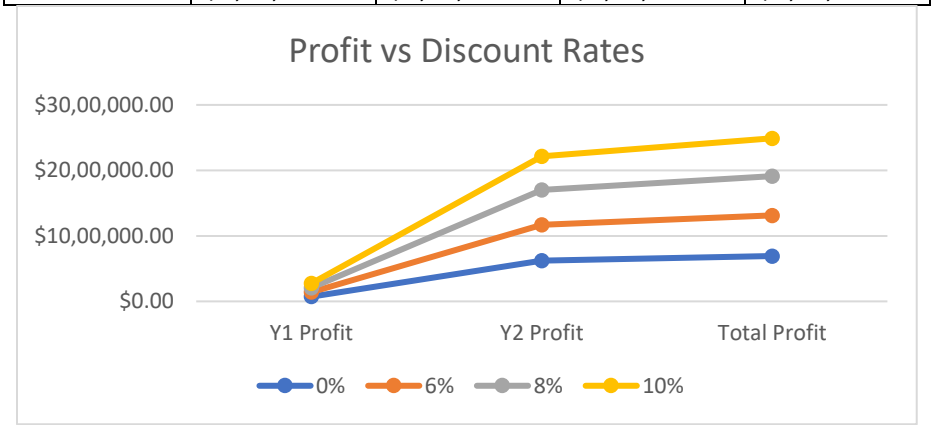
From our LP model, we can observe the following-

- With every 10% increase in cost of grapes, there is an approximate drop of **10%** in profit.



Results Sub- problem 3-

	Discount Rate			
	0%	**8%**	**6%**	**10%**
Y1 Profit	$72,681.56	$67,297.74	$68,567.51	$66,074.15
Y2 Profit	$6,19,963.02	$5,31,518.37	$5,51,764.88	$5,12,366.14
Total Profit	$6,92,644.59	$5,98,816.11	$6,20,332.40	$5,78,440.28



As clearly evident from the graph, the discount rate does not have a significant impact on the yearly and total profits.

	6%			8%			10%		
Name	OC	Max Inc	Max Dec	OC	Max Inc	Max Dec	OC	Max Inc	Max Dec
Qty produced petite	-0.75	3.69	123.87	-0.74	3.57	119.60	-0.73	3.45	115.56
Qty produced sauvignon	-0.66	83.06	3.05	-0.65	80.20	2.94	-0.64	77.49	2.84
Qty produced petite	-0.67	13.09	1.33	-0.64	12.61	1.28	-0.62	12.15	1.24
Qty produced sauvignon	-0.76	1.38	20.61	-0.73	1.33	19.86	-0.70	1.28	19.14
Cost for marketing petite	-0.94	18.46	619.34	-0.93	17.83	598.01	-0.91	17.23	577.80
Cost for marketing sauvignon	-0.94	68.74	24.37	-0.93	66.37	23.53	-0.91	64.13	22.74
Cost for marketing petite	-0.89	8.65	7.99	-0.86	8.34	7.69	-0.83	8.03	7.42
Cost for marketing sauvignon	-0.89	7.82	206.13	-0.86	7.53	198.57	-0.83	7.26	191.41
Units Sold petite	7.55	3.69	123.87	7.41	3.57	119.60	7.27	3.45	115.56
Units Sold sauvignon	6.60	1E+30	3.05	6.48	1E+30	2.94	6.36	1E+30	2.84
Units Sold petite	7.34	1E+30	1.33	7.07	1E+30	1.28	6.82	1E+30	1.24
Units Sold sauvignon	6.23	1.38	20.61	6.00	1.33	19.86	5.79	1.28	19.14

Recommendation

George should invest money in this business, this way, he'll not only pursue his hobby but earn a significant amount of profits. Even if the odds are against him and there is an increase in grape cost it will not affect him significantly, his profits will decrease, against what was anticipated in the best case but he still will get a very good overall return to his money.

Similarly, the discount rate should not be something to be worried about. George is correct and his colleague's concern on the discount rate does not affect the final profit significantly.